NON-PUBLIC?: N
ACCESSION #: 9505310478
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Fermi 2 PAGE: 1 OF 7

DOCKET NUMBER: 05000341

TITLE: Reactor Trip Due To High Neutron Flux Caused By A Reactor Pressure Transient
EVENT DATE: 04/25/95 LER #: 95-005-00 REPORT DATE: 05/25/95

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 087

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: IT COMPONENT: RG MANUFACTURER: G080
REPORTABLE NPRDS: N

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On April 25, 1995, at 1159 EDT, with the reactor at 87 percent power, the reactor automatically tripped on average power range monitor (APRM) upscale condition. All safety systems responded properly. The main generator did not automatically trip off-line. Manual trip actuation of the generator output breakers was required.

Based on post-transient recorder data, it was determined that a reactor pressure regulator failure caused the turbine control valves (TCVs) and turbine bypass valves (TBVs) to open, decreasing reactor pressure and increasing moderator void formation. Approximately four seconds later, the pressure regulator returned to normal control, the TBVs closed, and the TCVs returned to normal operation. The resultant reactor pressure recovery resulted in high neutron flux due to moderator void collapse.

Replacement of circuit boards, replacement of the pressure regulator

potentiometers, the additional testing to locate potential sources of voltage signal introduction or current loading, and removal of the pressure regulator monitoring system interconnection to the pressure regulator control circuitry provide a high level of confidence that the cause of the event has been corrected.

Additional investigation will be performed to attempt to determine the root cause at the component level. The scram response abnormal operating procedure has been revised to relocate verification of the output breakers being tripped from the subsequent scram section to the immediate actions section.

END OF ABSTRACT

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Table "REQUIRED NUMBER OF DIGITS/CHARACTERS FOR EACH BLOCK" omitted.

Initial Plant Conditions:

Operational Conditions: 1 (Power Operation)
Reactor Power: 87 Percent
Reactor Pressure: 1000 psig
Reactor Temperature: 544 degrees Fahrenheit

Background:

There are two pressure regulators IT!RG!, one normally in control and one acting as a backup, that operate the turbine control valves (TCVs)JJ!V! and the turbine bypass valves (TBVs)JI!V!, and thus control reactor pressure. The setpoints are adjusted by the control room operator depressing push buttons that drive motorized potentiometers (MOPs)IT!70!. The MOPs move from 0 to 1050 psi (full range) in approximately 17.5 minutes. The backup pressure regulator has a setpoint approximately three (3) psi higher than the pressure regulator in control.

The pressure signal from the associated pressure transmitter IT!PT! is compared with the pressure regulator setpoint. The resulting difference is the pressure error signal. The pressure error signal is processed to produce a pressure demand signal. The pressure demand signal from the pressure regulator in control is auctioneered against the pressure demand from the backup pressure regulator in a high-value gate in each pressure

regulator control module. This results in the selection of the pressure demand that will result in the largest valve flow demand. The selected pressure demand signal is then compared, through a low-value gate, with a reactor flow limiter. The reactor flow limiter, which acts as an adjustable setpoint, limits reactor system depressurization due to postulated maximum reactor steam flow for various reactor transients. The resulting signal is the pressure-steam signal which is transmitted through to the valve control module low-value selection gates. The pressure regulator controlling signal is compared with other turbine control signals before the fina
valve demand signal is selected. When
the turbine controls are in the "Pressure in Control Mode," the pressure regulator with the largest input differential between setpoint and actual pressure at the 52-inch common steam manifold (i.e., the one with the lower setpoint) is typically the TCV controlling signal.

During the fourth refueling outage (RF04), special flow straighteners were installed in the TCVs to minimize oscillations caused by steam flow turbulence at high reactor power. Prior to RF04, oscillations began showing up at approximately 90 percent power and limited the plant to 93.5 percent power. Sequence of Events (SOE) 94-04, "Pressure Regulator Testing," was developed

for the purpose of checking the basic stability of the pressure control system and to determine the optimum system settings resulting for the Fermi 2 power uprate program. A similar SOE had been performed with no problems as part of the power uprate program after the third refueling outage. The SOE inserts a step pressure change signal, by use of test switches on the pressure regulators, to the pressure regulator control circuitry downstream of the MOP setpoint. The resultant signal inserts a step change to the TCVS, which causes the TCVs to open and reactor pressure to decrease. After the test signal is removed, the TCVs begin to close and reactor pressure increases to the pre-test values.

During RF04, a pressure regulator monitoring system (PRMS)IT!MON! was connected to the pressure regulator control circuitry to provide retrievable monitoring of the pressure regulator system operation. The PRMS was also intended to provide improved reliability for operation of the pressure regulator system in the event of a failure in the control circuitry or of one of the pressure transmitters. PRMS post-installation testing would not be complete until higher reactor power levels were achieved, so only the monitoring portion of the PRMS circuitry was left enabled for plant restart in January, 1995. It was intended that the PRMS monitoring circuitry would have no impact on the operation of the pressure regulator control circuitry.

Description of Event:

On April 25, 1995, at 0930 EDT, with the reactor at 87 percent power, pressure regulator testing began in accordance with SOE 94-04. SOE 94-04 testing had been successfully completed for the introduction of one, two, four and six pound step changes to the pressure regulator control circuitry. At 0948 EDT, an eight pound step change was introduced. The pressure regulator did not respond as expected in that the plant experienced an approximate 12 psi pressure drop (instead of the expected 8 psi drop). Testing was stopped immediately and the pressure regulator circuitry was returned to the pre-test configuration. In addition to the unexpected reactor pressure drop, the following pressure regulator indication discrepancies were then noted: the pressure regulator setpoints as indicated in the control room were three psi higher than before the testing commenced; there was a 10 psi differential between the pressure regulator number 1 (PR1) and pressure regulator number 2 (PR2) setpoint readings in the relay room NA!; and the PR1 setpoint indicated in the relay room was 6 psi lower than the corresponding control room PR1 indication NA! PIC!. The reactor pressure stabilized at approximately 7 psi lower than before the testing commenced.

At this time, all test equipment was removed. The plant was operating at slightly below 87% power due to the reactor pressure decreasing to 1000 psi from the pre-test value of 1007 psi. The pressure regulator indication discrepancies were still evident after the removal of the test equipment. The associated control room annunciator NA!IB! for governor trouble was also energized since the alarm criterion of exceeding a 7 psi differential between the two pressure regulator error signals had been met. A briefing on the anomaly and a discussion on the course of action between startup test personnel and operations was held immediately. At approximately 1130 EDT, all involved personnel broke for lunch and agreed to reconvene at 1230 EDT after contacting the necessary additional support personnel. No activity on the pressure regulator control circuitry was in progress during this time. Prior to breaking for lunch, Operations personnel were aware that the backup regulator might not work (due to 10 psi offset between the regulators compared to normal 3 psi offset) and operator actions were discussed for potential failure modes.

At 1159 EDT, the plant scrammed on average power range monitor (APRM)JD!MON! neutron flux high caused by a reactor pressure transient. The scram abnormal operating procedure (AOP) was entered, and subsequently the emergency operating procedures (EOPs) were entered on reactor water Level 3 (L3) reactor protection system JC! initiation. The L3 setpoint is 173.4 inches above the top of active fuel and a minimum reactor water level of 121 -inches was reached during the transient. Based on sequence of event's recorder IQ!XR! data and General Electric Transient Analysis Recorder System (GETARS)IQ!XR!, it was determined that a reactor pressure regulator signal caused the TCVs and TBVs to open, decreasing reactor pressure and increasing moderator void formation. Approximately four seconds later, the pressure regulator returned to normal control, the TBVs closed, and the TCVs returned to normal operation. The resultant reactor pressure recovery resulted in high neutron flux due to moderator void collapse, resulting in the APRM scram signal on both divisions of the reactor protection system. All control rods fully inserted into the reactor core upon receiving the reactor scram signal.

The 345kV plant output breakers (CM & CF breakers)EL!52! did not automatically trip on reverse power as expected following the scram. Control room operators manually opened these breakers approximately nine minutes after the reactor scram. As a result, the generator TB!GEN! was motorized for several minutes, due to reverse power flow, at approximately 8 MW turbine demand load. Subsequent investigation determined that the reverse power relay FK!78! was functional, but that the sensitivity was too low to detect the reverse power current flow through the generator for the plant and Detroit Edison transmission system EL!FK! configuration present on April 25, 1995. The reverse power relay was found set at its lowest reverse power detection setting.

At 1220 EDT the reactor scram was reset. Following the scram reset one new rod drift alarm (CR 22-23)AA!ANN!ALM! would not reset. CR 22-23 was found to have a superimposed "9" units digit coincidental with display of a "0". A temporary modification was implemented to defeat the superimposed "9" unit.

Cause of Event:

A cause analysis was performed that focused on the fact that the TCVs opened to the turbine flow limiter preset value, and that the TBVs went full open in the first part of the transient, and then went full closed approximately four seconds later, ultimately resulting in the reactor scram. Using the TCV and TBV operation as a screening criteria, and based on the plant transient response data, the only potential causes of the transient and SOE 94-04 testing problems were within the pressure regulator control circuitry.

In parallel with the cause analysis investigation, pressure regulator control circuitry troubleshooting activities were performed. During this troubleshooting, the common comparator circuitry was found to have error signals different from expected. These readings were consistent with the SOE 94-04 testing problems previously described. Based on these test results, the comparator controller, setpoint indicator driver, and setpoint differential controller cards (boards A12, A10 and B14 respectively) IT!AIC! were replaced. Even though no MOP discontinuity problems were in evidence, as a prudent measure, the potentiometers for the MOPs were also replaced.

A review of the pressure regulator system schematic drawings determined that the most probable cause of the reactor scram was either a voltage signal introduction or a current loading effect taking place on the pressure regulator control module IT!PDCO! inputs to the pressure regulator common comparator circuitry. Based on this determination, additional troubleshooting activities were identified. As a prudent measure, several additional circuit boards were replaced. These additional troubleshooting activities determined that: the A12 board failure could not result in a voltage signal introduction of sufficient level to cause a drop in the setpoint that would open the TBVS; the power supplies IT!RJX! are providing adequate regulation for the installed configuration and operational requirements; and the PRMS can impact pressure regulator control circuits. As a result of these findings, the PRMS interface with the pressure regulator control circuitry was removed. This modification returned the pressure regulator control circuitry to its pre-PRMS operational configuration.

Due to the intermittent nature of the initiating pressure regulator transient, the component(s) which caused this event could not be conclusively identified. However, replacement of circuit boards, replacement of the pressure regulator potentiometers, the additional testing to locate potential sources of voltage signal introduction or current loading, and removal of the pressure regulator monitoring system interconnection to the pressure regulator control circuitry provide a high level of confidence that the cause of the event has been corrected.

Analysis of Event:

The April 25, 1995 plant response to the transient has been reviewed against Updated Final Safety Analysis Report (UFSAR) Sections 15.1.3 "Pressure Regulator Failure - Open" and 15.2.1 "Pressure Regulator Failure - Closed" and evaluators determined that this event falls within the existing safety analysis. The scram event was bounded by the pressure regulator failure event analyzed in Section 15.1.3 of the UFSAR because the regulator failure disappeared and reactor pressure recovered before the water level reached L8. The scram event was bounded by the pressure regulator failure event analyzed in Section 15.2.1 of the UFSAR because the scram signal was not the result of a main turbine TA!TRB! trip. Turbine trip transients produce peak pressures, powers, and changes in the critical-power-ratio (delta-CPR) much greater than those produced by pressure regulator failures.

Main generator anti-motoring protection is applied primarily for the benefit of the turbine. Loss of input to the prime mover with the generator breaker closed and generator field applied will result in the generator running as a motor connected to the high voltage system. From the electrical generator point of view (i.e., overheating), this condition usually presents no problem since the motoring power required from the system is on the order of three percent of the generator rating. The reverse power relay is set to pick-up at 0.5 to 1.0 percent of the generator rating. Part of the turbine overspeed protection scheme includes a 15 second delay for anti-motoring trip of the main generator to enable any reactor residual steam to enter the turbine prior to tripping the generator off-line. However, with insufficient steam pressure in the turbine, the turbine acts as a load on the system (called motorized), and the last stage turbine blades (currently removed from the Fermi turbines) may be damaged by overheating due to windage. The condition of the turbine and generator were reviewed for evidence of overheating. No abnormal temperatures or alarms were discovered.

Corrective Actions:

The circuit boa
ds that were replaced as part of the troubleshooting
activities will be tested to attempt further cause determination to the component level. In addition, investigation into the PRMS interface with the pressure regulator control circuitry will be conducted to determine the nature of the unexpected impact of the PRMS circuitry on the pressure regulator control circuitry.

The immediate actions of the scram response procedure (AOP 20.000.2 1) have been updated to require a positive verification of turbine trip when load demand is less than I 10 MW, and to open the CF and CM breakers when the turbine has been verified as tripped. This positive verification was previously a scram subsequent action. In addition a simulator software modification has been made to eliminate the automatic tripping of the CF and CM breakers on a reactor scram to reinforce the need to open the output breakers. An engineering evaluation is being performed to evaluate whether to pursue a long term design modification for the reverse power tripping of the CF and CM breakers.

Previous Similar Events:

LER 85-068, "Reactor Trip - Turbine Bypass Valve Failed Open," describes a reactor scram caused by a high reactor vessel water level due to the failure of the pressure regulator control circuitry due to motorized potentiometer discontinuity. The corrective actions for that event were to replace the motorized potentiometer circuit boards.

LER 93-007, "Reactor Trip on Intermediate Range Monitor Upscale During Reactor Pressure and Feedwater Transient," describes a reactor scram caused by the failure of the pressure transmitters that input into the pressure regulator control circuitry due to an improperly installed instrument line fitting. The corrective actions for that event included replacement of the pressure transmitters and addressed the personnel error associated with the improperly installed instrument line fitting.

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